UN Informal Meeting on Lithium Batteries – 2015-2016

2nd Session, 26-28 August 2015 – Washington, DC, United States

Day 1 – 26 August 2015

Introduction

1. George Kerchner (PRBA) welcomed the participants to the Session and introduced the logistics for the meeting. Claude Pfauvadel (Chairman) noted the scope of the meeting remains within the context of the testing criteria for lithium batteries as detailed in the UN Manual of Tests and Criteria (UN Manual) but also will include topics referred to the WG by the UN Subcommittee. The participants introduced themselves noting participation from several competent authorities as well as battery manufacturing companies, automobile manufacturers, and trade associations. The Chairman commented that the WG would not need to report all discussions and results to the UN Subcommittee; only those items which the WG felt were satisfactory developed.
2. Presentations for the session can be viewed at:. http://www.prba.org/laws-regulations/un-wg-meeting-on-lithium-batteries-august-2015/
3. The following action items were noted from the 1st Session:

Definitions

- WG to request clarification from the Subcommittee as to whether individual cells (single or component) may exceed 20 Wh.
- WG to request clarification from the Subcommittee as to whether the 20 Wh limit in SP 188 applies to cells contained in batteries or only to cells when transported as cells.
- Review proposed language addition to 38.3.2 for batteries installed in equipment.
- WG to review revised table for inclusion in UN Model Regulations and UN Manual.

Hybrid Batteries

- WG to continue discussion on hybrid batteries and determine if separate definitions and testing conditions are needed or whether simple clarification statements could be made. Options could include:
    i. Precise text depending on conditions, or
    ii. Principle agreement that primary takes precedent over secondary.
    iii. Issue to be presented to the UN Subcommittee for guidance to the WG on how to proceed.

New Battery Technologies

- WG to draft language to add to 2.9.4 to clarify that lithium metal polymer should be a lithium metal battery
- WG to draft language to T.7 and T.8 to clarify that these tests should be conducted at normal operating conditions [temperatures] for the battery.

- WG to research whether T.5 should be conducted at normal operating conditions [temperatures] for the battery.

Testing Requirements for Small Batteries with Large Cells

- WG to consider sliding scale for T.4 acceleration for cells (align with sliding scale for batteries)
- WG to consider redefining the definition of a large cell (currently at 12 kg)
- Participants were invited to provide additional technical data (testing data) to support the discussion

Standard format for Declarations of Conformity

- WG to review 6.1.5.7.1 and determine if text is usable as a basis for test report language.
- Report to Subcommittee that additional elements of conformity could be discussed within the WG at future sessions.

Internal Short Circuit Testing Methods

- WG to ask Subcommittee if development of an internal short circuit test should be included in the mandate for the Lithium Battery Working Group.

Damaged and Defective Batteries

- VDA to share damaged/defective transportation methodology with WG.
- WG participants to provide example guidance of how to handle such batteries to next WG meeting.
- WG to ask Subcommittee whether the WG can issue guidance or technical criteria for when lithium batteries are to be considered damaged for defective.

Test Failure Criteria

- WG to ask Subcommittee to add the issue of fail-safe devices to the fail criteria of the UN38.3 tests.

Definitions

4. IEC introduced a number of proposals to harmonize the definition of a single cell and single cell battery as used in the UN Manual of Tests and Criteria with those found in the IEC standards.
5. The WG discussed in principle the value of aligning the definitions with IEC Standards given the fact that the current language has been used in training and testing for the last several years and modifying the text as proposed at this point could create additional confusion. The WG noted the number of situations where both cells and batteries are used together which raises the question of why the UN Manual makes the differentiation or is there another way to approach the testing differences. Several participants commented simplification and clarification would be preferred, reiterating the point that the language and testing should be referenced in a way that

ensures safety of the product being shipped, not just to test because the UN Manual states it as so. The Chairman noted the WG did not generally support the proposals, but suggested clarification may be found in other proposals to be presented during the session. PRBA questioned whether the differences between IEC and the UN Manual created any additional testing for single or multi-cell batteries. IEC indicated no additional testing was created. The WG indicated it is very difficult to determine whether a battery is a single cell or multi-cell by just looking at it. The WG questioned what would result if the definitions were changed. IEC indicated that it would have very little change to the way the cells or batteries are shipped. The changes would only have an impact within the context of the UN Manual for cell/battery testing. The Chairman reiterated the definitions as they stand should be clear in the context of testing. If they work, then changes may not be necessary and could create unnecessary confusion. RECHARGE pointed out one of the mandates to the WG from the UN Subcommittee was to compare the definitions between the UN Manual, the UN Model Regulations, and relevant IEC Standards. Given the discussion, it may suffice that the WG conclude the definitions are slightly different but should remain so given the different use of the terms in each text, and report this result to the Subcommittee. The Chairman suggested the summary of the IEC presentation be referenced during the review of testing table proposals to be discussed later in the Session.

6. PRBA discussed the need for a definition of "Equipment" based on recent discussions at the UN Subcommittee. Reference was drawn to an existing definition in Special Provision 240. The word "equipment" is used ten (10) times in Special Provision 188 but no clear definition is provided. PRBA further drew attention to the use of the term in ICAO Packing Instructions PI967 and PI970 as well as in 49 CFR §173.185. PRBA proposed to add the following sentence to the end of SP188:

> *For the purpose of this special provision, equipment are devices intended to be <u>powered</u> by or used in the <u>operation</u> associated with the lithium ion or lithium metal cells or batteries packaged with or installed in the devices. Examples of such equipment include, but are not limited to, notebook computers, tablets, cellular phones, e-readers, medical devices, power tools, flashlights, battery chargers, circuit boards and toys.*

The WG discussed the value of providing a consistent understanding for testing and shipping. The Chairman pointed out the language in SP240 is to clarify what can be described as a "vehicle". Thus the reference to "equipment" is simply used as something other than a vehicle and therefore may not be a very good definition. Participants questioned whether a power bank should be considered equipment or a battery. The WG generally agreed that the definition would clarify that for the purposes of packing instructions, equipment would mean the equipment that the batteries are intended to power, and thus would be beneficial for considering lithium batteries packed with equipment. The issue of power banks was discussed but will be further addressed later in the session, although the question of including battery chargers was questioned. The WG noted benefit to include the text in P903 as well or perhaps putting the language in a separate SP such as SP230. The WG agreed to put the term "battery chargers" in square brackets pending the later discussion on batteries integral to equipment. For

the later discussion, the discussion will review whether a battery charger considered equipment or a battery. The issue of automotive battery converters was raised and whether they would be considered a battery or equipment. A parallel was drawn to the Formula 1 circuit where such power converters/energy recovery devices are tested and shipped as batteries. The WG agreed to the language in principle subject to additional discussions on battery chargers.

7. RECHARGE explained the need to differentiate between component cell and single cell for the purposes of testing pointing out several reasons where confusion exists in both the Model Regulations and the UN Manual. The WG suggested that any new UN numbers would not be considered Class 9 without some form of testing noting that other entries for batteries consider the material within the battery as the primary classification driver (for example, Div. 4.3 for batteries containing sodium). The WG also discussed the situation where a battery may be comprised of multiple electrochemical units which are not considered individual cells. The Chairman stated that the Subcommittee indicated the WG should not overcomplicate the issue. To address the point, the WG could develop a special provision that would explain which entry would apply to different battery chemistries, allowing to add new chemistries under the same proper shipping name.
    - The discussion can be summarized into several different points:
        i. Do entries for different chemistries need to be developed?
        ii. How to test a battery composed of several electrochemical units (not cells)?
        iii. Are the thresholds for small cells/batteries appropriate based on new technology? Is a new unit or measurement needed to determine safety limits?
8. IEC noted difficulty with the detailed wire mesh description in the definition for "disassembly" and proposed revised text:

    Disassembly means a vent or rupture where a cell container or battery case opens violently and solid components are forcibly expelled.

    Some participants agreed with the proposal. However, others noted a need to provide measurable and testable criteria to determine pass/fail. They indicated the proposed wording would result in a subjective decision as to pass/fail and could vary from test lab to test lab. Others indicated it is impractical to use the mesh during the tests and instead may indicate a test failure of any material is ejected beyond 25 cm from the battery. The WG noted that the change would impact tests T.6, T.7, and T.8. The Chairman stated that under the current provisions, a particle smaller than 0.25 mm could be expelled through the mesh today and would not result in a fail result. The WG discussed the need for a chart or table that could be used to determine acceptable mass of particles expelled associated with distance and resulting energy similar to Test Series 6(c) for explosives. Cell manufacturers indicated there is an acceptable level of disassembly and rupture that does not impact safety. The proposed definition might prevent any dangerous disassembly. The WG agreed to postpone a final decision on the proposal during this session but review alternative ways to measure acceptable disassembly.

Action Items

- WG to consider alternate ways to measure acceptable disassembly (such as using a process similar to that defined in Test Series 6(c) for explosives.
- Test labs and cell manufacturers to present examples of acceptable and unacceptable disassembly.

Summary Table of Cell and Battery Testing Requirements

9. RECHARGE presented a revised table for summarizing test applicability for cells and batteries. The table was based on the table discussed at the 1st Session in March 2015 but revised following previous discussions. RECHARGE also provided several optional tables which would incorporate more detailed information, including number of cells/batteries to be tested as well as number of cycles.

Primary cells and batteries		**T1** Altitude simulation	**T2** thermal test	**T3** Vibration	**T4** shock	**T5** External Short circuit	**T6** Impact/crush	**T8** Forced discharge
component cell (not transported seprately)	undischarged state						5	
	fully discharged state						5	10
Cell	undischarged state	10					5 (1)	
	fully discharged state	10					5 (1)	10 (1)
Single cell battery	undischarged state	10 (3)					5 (3)	
	fully discharged state	10 (3)					5 (3)	10 (3)
Small and large battery	undischarged state	4					5 (1)	
	fully discharged state	4					5 (1)	10 (1)
assembled battery with tested batteries	undischarged state			1				
Large assembled batteries		no testing if preventing overcharge short circuit and over discharge						
			(1) not applicable if already tested with the component cell					
			(3) not applicable if tested with the cell or the component cell					

Rechargeable Cells and batteries		**T1** Altitude simulation	**T2** thermal test	**T3** Vibration	**T4** shock	**T5** External Short circuit	**T6** Impact/crush	**T7** Overcharge	**T8** Forced discharge
component cell (not transported separately)	First cycle, 50% discharged						5		
	First cycle fully discharged								10
	50th cycle, fully discharged								10
Cell	First cycle, fully charged	10							
	First cycle fully discharged	10							10 (1)
	First cycle, 50% discharged						5 (1)		
	50th cycle, fully discharged						5 (1)		10 (1)
	50th cycle, Fully charged								
Single cell battery	First cycle, fully charged	10 (3)						4	
	First cycle fully discharged	10 (3)							10 (3)
	First cycle, 50% discharged						5 (3)		
	50th cycle, fully discharged						5 (3)		10 (3)
	50th cycle, Fully charged							4	
Small battery	First cycle, fully charged	4						4(2)	
	50th cycle, Fully charged	4						4(2)	
Large batteries	First cycle, fully charged	2						2 (2)	
	25th cycle, Fully charged	2						2 (2)	
assembled battery with tested batteries	First cycle, fully charged			1					
Large assembled batteries		no testing if preventing overcharge short circuit and over discharge							
			(1) not applicable if already tested with the component cell						
			(2) not applicable in case of exemption of 38.3.3.(d) for lack of overcharge protection						
			(3) not applicable if tested with the cell or the component cell						

10. IEC presented alternative table that were based on IEC Standard 62281. The IEC approach reversed the axes from the RECHARGE proposal, having the tests described in the horizontal rows and the number of cells or batteries listed in the vertical columns. Both a primary and secondary table would be necessary.

Tests	Discharge state	Cells [a]	Batteries
Tests T-1 to T-5	Undischarged	10	4
	Fully discharged	10	4
Test T-6	Undischarged	5	5 component cells
	Fully discharged	5	5 component cells
Test T-8	Fully discharged	10	10 component cells
Total for all tests		**40**	**8 batteries and 20 component cells**

[a] Single cell batteries containing one tested component cells do not require re-testing unless the change could result in a failure of any of the tests.

Tests	Cycles and discharge state	Cells	Single cell batteries [a]		Batteries	
			Small	Large	Small	Large
Tests T-1 to T-5	At first cycle, fully charged	10	10	10	4	2
	After 25 cycles, fully charged	N/A [b]	N/A [b]	N/A [b]	N/A [b]	2
	After 50 cycles, fully charged	N/A [b]	N/A [b]	N/A [b]	4	N/A [b]
Test T-6	At first cycle, at 50 % DOD	5	5	5	5 component cells	5 component cells
Test T-7	At first cycle, fully charged	N/A [b]	4 [c]	2 [c]	4 [c]	2 c
	After 25 cycles, fully charged	N/A [b]	N/A [b]	2 [c]	N/A [b]	2 [c]
	After 50 cycles, fully charged	N/A [b]	4 [c]	N/A [b]	4 [c]	N/A [b]
Test T-8	At first cycle, fully discharged	10	10	10	10 component cells	10 component cells
	After 50 cycles, fully discharged	10	10	10	10 component cells	10 component cells
Total for all tests		**35**	**43**	**39**	**16 batteries and 25 component cells**	**8 batteries and 25 component cells**

[a] single cell batteries containing one tested component cell do not require re-testing unless the change could result in a failure of any of the tests, except for test T-7 where only batteries are tested.

[b] N/A = not applicable.

[c] batteries not equipped with overcharge protection that are designed for use only in a battery assembly, which affords such protection, are not subject to the requirements of this test.

11. The WG discussed the advantages and disadvantages of the tables and made suggestions to improve both. Concerns were voiced regarding the IEC table where it combines the component cell and battery quantities. Some participants noted the table may be too simple and could lead to confusion. The Chairman indicated for complicated conditions, such as when large assembled batteries are exempted from certain tests, a reference to the exception could be noted instead of a wordy entry. Based on the discussion, both RECHARGE and IEC agreed to revise their tables, PRBA agreed to summarize the advantages, and the WG agreed to review on Day 2.

Test Reports

12. PRBA reviewed discussions at the 1st Informal WG Session and the July 2015 UN Subcommittee regarding possible templates for battery test reports. PRBA pointed out much of the information contained within test reports may be proprietary. Therefore, test laboratories may issue up to 3 different documents:
    - Detailed Test Report
    - Pass/Fail Report
    - Certification of Conformity
13. PRBA proposed adopting a set of information which could be used as a basis for an acceptable test report for confirming test criteria:
    - Name of battery manufacture or brand name on battery
    - Name of third party test lab (if applicable)
    - A unique test report identification
    - Date of test report
    - Description of cell or battery (e.g., Li ion or Li metal cell or battery, voltage, Watt-hour rating, grams of lithium metal content, model number)
    - List of tests conducted and results (i.e., pass/fail) – Is "fail" really needed?
    - Statement that cell or battery has been tested in accordance with UN Manual of Tests and Criteria, Section 38.3
    - Test report shall be signed with name and status of signatory
14. The WG discussed the benefit of such a document. Further suggestions included:
    - Adding the net mass of the cell/battery,
    - A statement that the cell/battery was constructed under a quality management system,
    - A statement for large batteries assembled of tested cells/batteries (38.3.3(f) or (g)),
    - Point of contact for questions,
    - Physical description and/or picture of the cell/battery that is auditable,
    - Version of the UN Manual tested,
    - Size/kind and manufacturer of cells used for batteries.
15. The Chairman noted that the tests are of a design type. Therefore, reference to model number or description should take into account that minor variability that does not affect test results are acceptable. The WG further discussed the benefit of providing additional data from the tests. Participants suggested instead of detailed test data, a reference to the test report maintained by the test lab or manufacturer could be referenced. Several participants noted confusion as to whether the list would be for the test report or a declaration of conformity. Noting the Subcommittee was not in favor of a declaration for conformity, the Chairman noted the statement that a cell/battery has passed UN38.3 may not be needed. The WG concluded that a test report should contain a minimal set of information to allow for a clear indication the cell/battery has passed relevant tests, and include enough information to allow for enforcement officials to follow-up with manufacturer or test lab if more information is needed. PRBA

indicated they would revise their proposal based on discussions and present a new proposal on Day 3.

End of Day 1

Day 2 – 27 August 2015

Hybrid Batteries

16. IEC presented information on hybrid batteries which contain both primary and rechargeable batteries. To provide clarity in the regulations, IEC proposed a definition of "hybrid battery", testing requirements, and identification as a lithium metal battery. The Chairman noted the description covers a particular type of hybrid battery today, but any language adopted must be broad enough to cover other technology designs including ultracapacitors. The WG discussed that current hybrid batteries are tested and offered as lithium metal batteries, but the rechargeable cells contained within are tested as lithium ion cells. Such batteries are currently used in water and gas meters. Some participants felt the best approach would be to include such information in a special provision in the UN Model Regulations. Others questioned whether it made sense to include the testing requirements in a special provision in the UN Model Regulations and not in the UN Manual. The WG concluded the special provision could be noted in both locations (e.g. in 38.3.2.2). Questions were raised about how rechargeable cells are prevented from overcharge and whether the definition would require new battery designs to include overcharge protection. Also, the group discussed whether it made sense to describe the batteries as both Lithium Metal and Lithium Ion. The Chairman suggested dropping the term "hybrid battery" and simply describe the identification and testing of these batteries. The WG decided to continue to review the topic without any decisions.

17. PRBA discussed whether a small lithium battery (not exceeding 2 g or 100 Wh) may contain lithium cells that exceed the applicable cell limit (not exceeding 1 g or 20 Wh). The WG reviewed a proposal to amend SP188 to clearly indicate the cell limits do not apply to cells contained within a battery. The Chairman reminded the WG that the UN Subcommittee did not have a definitive opinion on the issue and requested the WG review the issue. The Subcommittee expressed the opinion that the limits should be considered independently. Participants discussed whether there was a safety risk in allowing a large cell in a small battery. The Chairman noted the values were adopted based on available technology at the time and not necessarily on a particular energy limit. It was noted that for a primary cells and batteries, the cell limit is 50% of the battery total. Therefore it might make sense to raise the rechargeable cell limit to 50% of the battery limit (up to 50 Wh for each cell). It was reminded that the Wh rating of the cells inside a battery is not available. It was noted the Subcommittee needs clear justification or data to support any decision or recommendation. The risk of propagation is the key concern, and therefore there is a difference between cells and batteries. Several participants felt it was important for more data to be used to justify any final decisions from the

WG. However, the WG acknowledged the issue needs to be clarified. No conclusions were made.

Rechargeable Lithium Metal Batteries

18. The Korean Battery Industry Association (KBIA) proposed amending the provisions for lithium metal batteries and special provision SP188 to address rechargeable lithium metal batteries. Noting that the maximum nominal energy has been reached for lithium ion cells in current designs, new technologies are being developed to increase energy density. KBIA proposed describing and limiting these batteries by Wh instead of grams of lithium. The presentation provided a history of the decision process for determining both cell and Wh limits for lithium ion batteries. The WG discussed how the lithium metal content varies with state of charge. Theoretically, at 0 SOC, the lithium metal content would approach 0. However practically, even a small amount of lithium metal will remain in the cell. It was noted the UN Manual tests do not distinguish between lithium metal or lithium ion but instead focus on primary or rechargeable. The Chairman reminded the WG that this issue was discussed by the Subcommittee, and the Subcommittee recommended the WG consider simplifying the proper shipping name and refer to specifics for the battery in a special provision. Some participants voiced concern that these batteries could contain lithium metal but be described as lithium ion batteries. The Chairman clarified that the proposal would not identify the batteries as lithium ion; they would be described as lithium metal batteries. The WG noted a difference between the definition of lithium content in the UN Manual and the limitations in SP188, and thus acknowledged something needed to be done. However participants pointed out that the logic and limits for lithium ion batteries is not directly related to limitations for lithium metal batteries. For example, a rechargeable lithium metal battery could have a Wh rating of 40 Wh but would contain 3 g of lithium. Therefore as a lithium ion battery, it would be eligible for exceptions under SP188. But as a lithium metal battery, it would be a fully regulated battery that has further restrictions by air. The WG discussed the possibility that the current system may not be adequate to address these types of batteries and additional testing may be needed. After significant discussion, there was no consensus on the fact that the batteries should be described by Watt-hour rating given that it could lead to a lithium metal battery with more than 2 g of lithium content. The WG agreed the need to continue to review further data on safety test of such batteries to ensure they are safe for transport. In addition, concerns were raised about the risk that all rechargeable Li metal batteries may not have the same level of safety.

Fail Safe Requirements

19. Motorola Solutions proposed modifications to the UN Manual 38.3.3 regarding cycling as well as revisions to account for fail-safe designs. Specifically, the number of cycles for small batteries was proposed to drop from 50 to 25 cycles. Additionally, they suggested cycling should be moved from batteries to cells to allow for recognition of cell anomalies. Finally, for T.1 through T.4, the open voltage requirement (90%) does not allow for a resettable fail-safe device which makes the cell safer.

20. Regarding the cycling issue, some participants in the WG did not see a technical justification for reducing the number of cycles. Motorola responded that based on IEEE discussions during standard development, dendrite growth during plating occurs by the 25th cycle. Therefore additional cycling beyond the 25th cycle was not necessary. The WG did not agree as to whether the cycling should be applied to the cell or to the battery, noting experience in testing that resulted in battery failures on cycled batteries. IEEE1725 as well as IEC performance standards already require cell cycling and therefore the cells are cycled during tests similar to T.1-T.5, just not under the UN38.3 testing. But they acknowledged that there appeared to be no requirements for cycling single cell batteries and they may not have been intended. Some felt the question should be posed to a broader variety of cell manufacturers, battery manufacturers, test laboratories, and competent authorities. However, the WG felt additional data would need to be presented before adopting the proposal. The WG was supportive of reviewing the number of cycles but requested additional technical data be presented as well.
21. Regarding the fail-safe criteria (circuit interruption devices or CID), several participants noted it was illogical to fail a cell or battery when a safety device had activated and supported the approach. Others noted that failures may need to be inspected physically to confirm that it the drop in voltage is not due to a loose connection which could lead to a short circuit within the battery. The WG discussed whether it would be acceptable for a CID to activate and continue the tests without resetting. One suggestion was to revise the proposal to add clarification that if a CID was activated during the test, the device could be reset immediately after the test and then the voltage checked and compared to the 90% requirement. After a lengthy discussion, the WG supported the need to take into account this type of device into the testing regime. However, they voiced doubt on how to deal with non-resettable devices and whether tests should be continued after a CID was activated.

Action Item

- Motorola Solutions to provide additional technical data to support reduction in cycling and moving cycling requirement from batteries to cells.
- Participants are invited to submit additional proposals and ideas to address the CID issue.
- WG to report to the Subcommittee the results of the discussions.

Damaged and Defective Battery Packaging

22. Diamler discussed the provisions for shipping damaged or defective lithium batteries and proposed additions to SP376 to permit transport without an approval if the battery is packed in accordance with a new special provision P9xx. The text proposed was based on existing approvals issued in Europe. Several packaging designs and testing videos were reviewed. The Chairman pointed out the mandate of the WG does not necessarily include packaging for damaged and defective packaging. However, the proposal in SP376 addresses the definition of a damaged/defective battery and that is within the mandate. The WG discussed how shippers would determine if a battery was damaged and defective and whether an approval is needed. Some participants supported the concept, suggesting that the proposal could be split into

revisions to SP376, a new Pxxx and a new section in Part 6 specific to packaging design and testing. However others felt the provisions could be simplified and not require a new specific design type. The WG suggested the content of the proposal could be modified simply and submitted to the Subcommittee as a formal paper for the December 2015 Subcommittee session.

Action Item

- Daimler to prepare a formal paper for discussion at the 47th UN Subcommittee Session.

End of Day 2

Day 3 – 28 August 2015

Damaged/Defective Batteries

23. DGAC discussed the history of damaged/defective lithium battery provisions and proposed criteria which could be used to determine if a battery needed to be treated as damaged/defective. They proposed changes to SP376 based on checklists already in use in industry. It was suggested that a battery which has undergone a complete reaction (e.g. has vented and no longer contains any electrolyte) would not be regulated as a battery. The Chairman commented that the original text was developed to provide guidance as to how to determine when a battery would be considered damaged or defective but could be improved. The WG discussed the benefit of the approach discussed by Daimler by separating such batteries in to three categories (not damaged, damaged but no approval needed, approval needed to ship) but revised to include concepts introduced by DGAC and PRBA. It was clarified the proposal was to revise just the beginning of SP376 and did not represent a full revision to the SP. The Chairman indicated the proposals must be viewed in a global sense and not independent of each other. Some participants voiced concern that the packaging must also consider risk of explosion and projectile ejection as testing has shown that large numbers of batteries in a single consignment could present such hazards. The WG agreed to present the discussion to the Subcommittee through the Daimler proposal and to incorporate the DGAC/PRBA proposals into the discussion.
24. The WG reviewed examples of industry checklists and practical guidance used to determine if lithium batteries are damaged/defective. Some checklists reviewed had simple yes/no questions but had in-depth explanation of the procedures and data collection methods used to make the yes/no determination. It was noted there are different battery chemistries and battery designs and therefore there cannot be a one-solution-fits-all. The Chairman suggested the WG could develop standard protocols for different categories of batteries (e.g. large complicated batteries, small consumer batteries). The WG suggested such protocols should be developed and provided by cell/battery manufactures. SAE J2950 and J2990 were referenced as additional documents that could be used in the review process. Participants agreed such information should not be mandated by regulation but instead would be provided as guidance. Other participants cautioned that even clear guidance would not necessarily provide a safe way to

transport such batteries. The WG concluded future work would include developing a list of criteria to consider and simple instructions on how to evaluate the criteria.

Action Items

- WG to develop list of criteria used to determine if battery is damaged/defective and simple instructions on how to evaluate the criteria.
- WG to report effort to Subcommittee and ask to add work to WG mandate.

Tables for Cell/Battery Testing

25. The WG reviewed the revised tables presented by IEC and RECHARGE for battery testing. The Chairman noted the effort was to simplify a very complicated paragraph in the UN Manual but the tables have progressively become more complicated. However, the new table would replace text from both 38.3.2.1 and 38.3.3. The WG provided comments to both presenters on improvements and editorial changes to the tables. It was noted there would still need to be a paragraph to 38.3.2.1 that introduces the table. Although there was significant discussion on the contents of the table, the Chairman recommended the table be developed in draft form and then presented to the Subcommittee for additional comment and revision. The WG discussed the concept of a component cell and whether the exception was appropriate. However, the Chairman noted this was a separate issue and must be addressed at a future session. Some participants also voiced concern over testing of large assemblies and single cell batteries. The WG concluded the table format which reflects the current scope and testing requirements is a valuable way to review the requirements. Therefore, it was proposed that the table reflects the testing conditions for all type of cells and batteries. As a result, participants have raised a number of interpretive questions which can be discussed at a future session. These include:
    - Testing requirements for single cell batteries
    - Testing requirements for component cells which are not transported outside a battery
26. The WG agreed to present the draft form of the tables to the Subcommittee for review and comment, with the intention that feedback will be used to develop a formal proposal at the next WG Session. See draft tables in Annex.

Action Items

- The WG will present the draft tables to the Subcommittee for review and comment.

Testing Lithium Batteries Integral to Equipment

27. PRBA explained the difficulty with testing of batteries that are integral to equipment such as power packs. PRBA suggested it would be acceptable to test the battery within the equipment. Specifically, a sentence is proposed to be included at the end of the scope:

    38.3.2.1 …A cell or battery that is an integral part of the equipment it is intended to power that is transported only when installed in the equipment, may be tested in accordance with the applicable tests when installed in the equipment.

28. In general, the proposal was supported in principle. Suggestions were made to reverse the language by indicating that the equipment must be tested as a cell or battery instead of explaining that a cell or battery may be tested while in the equipment. It was noted that the definition of a battery already states that a battery includes devices which are necessary for use and that concept should not be lost. Some participants cautioned that the language should not be too broad as to require equipment testing as batteries in all cases. However, any solution must ensure that that safety is maintained and batteries are tested as required. After further discussion, the WG supported the need for some language to clarify the issue but recognized any language should not create different interpretations between the UN Manual and the UN Model Regulations. No final language was agreed but the WG agreed to continue discussion at the next session.

Testing Report

29. The WG reviewed revisions to the sample Lithium Battery Test Report. General support was given for the draft shown below and the WG recommended the draft version, with minor amendments, be presented to the Subcommittee for additional comment.

Proposed Lithium Battery Test Report

1. Name of cell or battery manufacturer or brand name on battery
2. Name of third party test lab (if applicable)
3. A unique test report identification
4. Date of test report
5. Description of cells or batteries (e.g., Li ion or Li metal cell or battery, voltage, net weight, Watt-hour rating, grams of lithium metal content, model number)
6. List of tests conducted and results (i.e., pass/fail)
7. Reference to assembled battery testing requirements, if applicable (i.e., 38.3.3(f) and 38.3.3(g))
8. Test report shall be signed with name and status of signatory
9. Contact information to include phone number, email address or website for more information

30. The WG reviewed the revised text for hybrid batteries. Comments were made to add […"only" charged…], and divide the long sentence in several points. It was also recommended to refer to the provisions of 2.9.4. (b) to (e).
    Final proposal draft Proposal

    Enter a new Special Provision referring to UN Numbers 3090 and 3091:

    A lithium battery containing primary lithium metal cells and rechargeable lithium ion cells shall be carried as a lithium metal battery if it meets the following:

    (a) it is not designed to be externally recharged; and
    (b) the rechargeable cells are only charged from the primary cells; and
    (c) overcharge of the rechargeable cells is precluded by design; and
    (d) the battery has been tested as a lithium primary battery; and
    (e) its component cells are of a type proved to meet the respective testing requirements of the Manual of Tests and Criteria, part III, sub-section 38.3; and
    (f) it meets the provisions of 2.9.4. (b) to (e).

End of Day 3

Annex

Add sentence to the end of SP188 [and SP230 or a new SP]:

> For the purpose of this special provision, equipment are devices intended to be powered by or used in the operation associated with the lithium ion or lithium metal cells or batteries packaged with or installed in the devices. Examples of such equipment include, but are not limited to, notebook computers, tablets, cellular phones, e-readers, medical devices, power tools, flashlights, [battery chargers,] circuit boards and toys.

RECHARGEABLE CELLS AND BATTERIES

Tests	Cycles and Discharge State	Cells [a]	Batteries and Their Component Cells			Assembled Batteries [b]
			Component Cells	Batteries		
				Small	Large	
Tests T-1 to T-5	At first cycle, fully charged	10	X	4	2	1
	After 25 cycles, fully charged	X	X	X	2	X
	After 50 cycles, fully charged	X	X	4	X	X
Test T-6	At first cycle, at 50 % DOD	5	5	X	X	X
Test T-7 [c]	At first cycle, fully charged	X	X	4	2	1
	After 25 cycles, fully charged	X	X	X	2	X
	After 50 cycles, fully charged	X	X	4	X	X
Test T-8	At first cycle, fully discharged	10	10	X	X	X
	After 50 cycles, fully discharged	10	10	X	X	X
TOTALS		**25**	**35**	**16**	**8**	**1**

[a] Except for the T7 Overcharge test, a single cell battery containing one tested cell does not require testing unless a change in cell design could result in a failure of any tests. When conducting T7 test on single cell battery, follow testing requirements for batteries.

[b] Only T3, T4, T5 and T7 required for one assembled battery with not more than 500 g lithium content or 6,200 Watt-hours, as applicable, that is assembled from batteries that have passed all applicable tests. See 38.3.3(f).

When batteries that have passed all applicable tests are electrically connected to form a battery with more than 500 g lithium content or 6,200 Watt-hours, as applicable, it does not need to be tested if the assembled battery is of a type that has been verified as preventing (i) Overcharge; (ii) Short circuits; and (iii) Over discharge between the batteries. See 38.3.3(g).

[c] Batteries or single cell batteries not equipped with battery overcharge protection that are designed for use only as a component in another battery or in equipment, which affords such protection, are not subject to the requirements of this test. See 383.3(d), last paragraph.

PRIMARY CELLS AND BATTERIES

Tests	Discharge state	Cells [a]	Batteries and Their Component Cells			Assembled Batteries [b]
			Component Cells	Batteries		
				Small	Large	
Tests T-1 to T-5	Undischarged	10	X	4	2	1
	Fully discharged	10	X	4	2	X
Test T-6	Undischarged	5	5	X	X	X
	Fully discharged	5	5	X	X	X
Test T-8	Fully discharged	10	10	X	X	X
TOTALS		**20**	**40**	**8**	**4**	**1**

[a] A single cell battery containing one tested cell does not require testing unless a change in cell design could result in a failure of any tests.

[b] Only T3, T4 and T5 are required for one assembled battery with not more than 500 g lithium content or 6,200 Watt-hours, as applicable, that is assembled from batteries that have passed all applicable tests. See 38.3.3(f).

When batteries that have passed all applicable tests are electrically connected to form a battery with more than 500 g lithium content or 6,200 Watt-hours, as applicable, it does not need to be tested if the assembled battery is of a type that has been verified as preventing (i) Overcharge; (ii) Short circuits; and (iii) Over discharge between the batteries. See 38.3.3(g).